UNITED STATES AIR FORCE

Installation Restoration Program

Proposed Plan for Interim Remedial Action at Installation Restoration Program Site 29 Air Force Plant 42 Palmdale, California

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Acronyms

µg/L	micrograms per liter
AFCEE	Air Force Center for Engineering and the Environment
AFP	Air Force Plant
ARARs	Applicable or Relevant and Applicable Requirements
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chemical of concern
EPA	Environmental Protection Agency
gpm	gallons per minute
GWTS	groundwater treatment system
HI	hazard index
IRP	Installation Restoration Program
LGAC	liquid-phase granular activated carbon
MCL	Maximum Contaminant Limit
mg/L	milligrams per liter
NCP	National Contingency Plan
O&M	operation and maintenance
ppmv	parts per million, by volume
PP	Proposed Plan
RAO	remedial action objective
RAP/IA	Remedial Action Plan/Interim Action
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence
SVE	soil vapor extraction
TCE	trichloroethylene
VGAC	vapor-phase granular activated carbon

This Proposed Plan (PP) summarizes the interim remedial action alternatives evaluated and the preferred interim remedial action alternative for the Installation Restoration Program (IRP) Site 29 at Air Force Plant 42 (AFP 42) located in Palmdale, California (Figure 1). Site 29 consists of the trichloroethylene (TCE)-impacted vadose zone and groundwater at Plant Site 1.

The goal of the preferred interim remedial action alternative, Groundwater Containment and Source Area Soil Vapor Extraction (SVE), is to reduce TCE contamination in soil and groundwater to levels that are protective of human health and the environment. The proposed interim remedial action is intended to be compatible with the final remedy for the site. Data acquired during this interim action will be used to develop the final remedy.

This PP summarizes information that can be found in greater detail in the *Remedial Investigation (RI) Report for Operable Units 1, 2, 3, 4, and 5* (CH2M HILL, 2003), *RI Report Addendum for IRP Site 29* (CH2M HILL, 2006), *Results of the 2007 Semiannual Groundwater Monitoring Events at IRP Site 29* (CH2M HILL, 2008a), *Soil Vapor Extraction System Installation and Startup Report for IRP Site 29* (CH2M HILL, 2008b), and *Remedial Action Plan/Interim Action (RAP/IA) at IRP Site 29* (CH2M HILL, 2008c). The environmental investigations were carried out in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP). The Air Force and the State of California encourage the public to review this PP and the above-referenced documents that can be found at the AFP 42 Information Repositories to better understand the activities conducted at Site 29. Underlined terms in this PP are defined further in the glossary in Appendix A.

1.0 Site Background

Site 29 is located at Plant Site 1 in the northwestern portion of AFP 42 (Figure 2). The two main aircraft hangars at Plant Site 1 were constructed in 1953 and 1955, respectively (Figure 3).

In 1973, Building 150 was modified to extend northward and heighten the roof to accommodate the tail of the space shuttle. The expansion on the north side of Building 150 is referred to as the High Bay. Based on historical aerial photographs, the area appeared to be asphalt paved prior to the addition of the High Bay. Building 150 was approximately 200 feet long by 300 feet wide prior to the addition of the High Bay. The High Bay is approximately 100 feet long, 300 feet wide, and 86 feet high, expanding the footprint of Building 150 to approximately 300 feet by 300 feet.

TCE was first detected in 1994 in groundwater at Site 29 in a former production well (DW1-2) located to the southeast of Building 150 (Figure 3). Use of the well was discontinued, and was subsequently destroyed. Since 2000, when the Air Force identified Site 29 as an IRP site, two major phases of RIs have revealed TCE in groundwater at concentrations exceeding its maximum contaminant level (MCL) of 5 micrograms per liter (µg/L). Monitoring wells were installed to characterize the horizontal and vertical extent of TCE in groundwater, and the Air Force continues to monitor them on a semiannual basis. Two drinking water supply production wells, DW1-1 and DW1-3, are currently active in the area; these wells are located south-southwest and downgradient of the TCE plume.

2.0 Previous Investigations

Previous investigations conducted at Plant Site 1 include record reviews, soil gas surveys, shallow soil, deep soil, and groundwater investigations. Detailed results of these investigations are provided in the RI Report for Operable Units 1, 2, 3, 4, and 5 and the RI Report Addendum for IRP Site 29.

TCE is the only chemical of concern (COC) identified at Plant Site 1. Based on the results of RI activities at Site 29, TCE releases appear to have occurred at the former northern edge of Building 150, corresponding to the former north hangar doors before the addition of the High Bay. An unknown quantity of TCE has been released; historical records do not indicate that TCE was used during any operations at Plant Site 1.

3.0 Nature and Extent of Contamination

The nature and extent of TCE at Site 29 are determined based on information obtained from completed RI activities. The site history, nature and extent of contamination, hydrostratigraphy, receptor information, and groundwater modeling have been used to develop and refine the conceptual model of the site.

A portion of the TCE migrated to the groundwater after estimated release date(s) between 1955 and 1973. The apparent confinement of the contamination to the shallow groundwater appears to indicate the TCE reached the groundwater and either dissolved in infiltrating water or in the vapor phase originating from residual TCE trapped in the vadose zone. If so, it appears likely that some TCE remains in the saturated zone, probably held at residual saturation by capillary forces. The majority of the mass of TCE remaining in the vadose zone and groundwater is located beneath Building 150.

TCE concentrations in groundwater appear to decrease with depth and decrease laterally away from Building 150. The current direction of groundwater flow is to the south, largely controlled by the pumping of two production wells (DW1-1 and DW1-3) located at Plant Site 1, approximately 1,350 feet south of the source area (Figure 4). The absence of significant detections of TCE degradation products and relatively high dissolved oxygen present in shallow groundwater indicates that naturally occurring biodegradation is not likely.

The estimated area where TCE concentrations in groundwater exceed the MCL of 5 µg/L is approximately 27 acres, as shown in Figure 4. The highest concentrations of TCE in the groundwater are located in the upper 60 feet of the aquifer.

4.0 Summary of Site Risks

The human health risk assessment for Site 29 is presented in the RI Report (CH2M HILL, 2003) and Site 29 RI Report Addendum (CH2M HILL, 2006). The risk assessment includes an evaluation of potential risks to current and potential future workers posed by exposure to soil and groundwater. Supplemental evaluation of potential indoor air risks was performed for the Site 29 RI Addendum (CH2M HILL, 2006). Because the land use

at AFP 42 is currently industrial and is planned to remain industrial for the foreseeable future, no residential risk assessment was performed. In addition, no ecological risk assessment was warranted because the Site 29 area does not provide viable ecological habitat (i.e., the site area is paved and does not support vegetation).

Noncancer risk is evaluated in terms of a hazard index (HI), which is the ratio of the estimated concentration to which an individual is being exposed to a threshold level concentration that would likely result in adverse health effects. If the HI is above 1.0, then there is a possibility that there might be adverse health effects caused by the chemical. The HI values for the current security/maintenance worker and current occupation worker scenarios at Site 29 are less than 1.0. However, the HI value (2.9) for the potential future security/maintenance worker, trench worker, and occupational worker scenarios exceeds 1.0. Greater than 99 percent of the noncancer risk at Site 29 is due to TCE in groundwater.

Cancer risk is expressed in terms of the probability that an individual or a particular group of individuals would have an increased chance of contracting cancer over a lifetime period of 70 years. For example, a risk of $1x10^{-6}$ means that an exposed person could have an increased likelihood of 1 in a million to develop cancer. An increased likelihood of cancer that is higher than $1x10^{-6}$ may require remedial action. The cumulative potential excess lifetime cancer risk estimates for Site 29 are greater than $1x10^{-6}$ for all worker scenarios evaluated, ranging from $1.8x10^{-6}$ (current security/maintenance worker scenario) to $6.7x10^{-5}$ (potential future occupational worker scenario). The vast majority of the cumulative cancer risk at Site 29 is due to the presence of TCE in groundwater at Plant Site 1, which contributes 65 to 100 percent of the cumulative risk. The maximum cumulative cancer risk associated with soil is $1.3x10^{-6}$ (current and potential future occupational worker scenarios).

It is assumed that TCE concentrations detected in groundwater monitoring wells represent potential future drinking water quality. The cumulative risk estimates are higher for the potential future exposure scenarios than for the current exposure scenario, because TCE concentrations detected in the groundwater monitoring wells used for the future receptor scenarios are higher than those found in the production wells at Plant Site 1, which are used for the current receptor scenarios.

5.0 SVE Pilot Testing

To evaluate appropriate vadose zone treatment technologies that could be used at Site 29, SVE pilot testing was performed at the site. The following section describes the SVE pilot testing activities.

In April 2006, an SVE system, located near the northwest corner of Building 150, was constructed and included four soil vapor extraction wells, located along the north side of Building 150 (Figure 3). Extracted vapor from the wells is treated using vapor-phase granular activated carbon (VGAC). The SVE system was designed with four extraction wells to remove TCE mass in the soil that is currently impacting the groundwater.

Field testing was performed to evaluate the vacuum radius of influence (ROI) of each extraction well. Based on field measurements, the estimated vacuum ROIs of approximately 95 feet to 210 feet, in conjunction with the high extraction rates (greater than 300 standard

cubic feet per minute) and the high estimated soil permeabilities to air flow, suggest a relatively large capture zone for soil vapors that is effective in capturing TCE mass beneath Building 150. Capture zones of this size further suggest the site is highly amenable to SVE treatment. The details of the SVE startup procedures and results are documented in the *Soil Vapor Extraction System Installation and Treatability Study Evaluation* (CH2M HILL, 2008b). The details of the SVE pilot testing are available in the *Final Semiannual Treatability Study Report Soil Vapor Extraction System at IRP Site 29* (CH2M HILL, 2008d).

6.0 Interim Remedial Action Objectives

Based on the evaluation of the site conditions, nature and extent of contamination, and risks associated with Site 29, the following interim remedial action objectives (RAOs) have been established to protect human health and the environment.

- Reduce TCE migration from the source area
- Contain and treat groundwater at AFP 42 with TCE concentrations greater than the MCL of 5 µg/L
- Reduce impact of TCE migration on downgradient AFP 42 water supply wells
- Prevent exposure to TCE concentrations above the MCL in groundwater
- Reduce TCE in soil gas to levels that are protective of groundwater as a potential drinking water source.
- Prevent unacceptable exposure of potential future workers to TCE in groundwater

7.0 Interim Target Cleanup Goals

Specific interim Target Cleanup Goals (TCGs) for groundwater and soil gas were developed to meet the interim RAOs described above. Because wells DW1-1 and DW1-3 are both active production wells, the proposed interim TCG for TCE in groundwater is the MCL of 5 µg/L to be protective of current and future workers. The proposed interim TCG for TCE in soil gas at Site 29 is 3.9 parts per million, by volume (ppmv).

8.0 Interim Remedial Action Alternatives

Four interim RAOs were assembled and evaluated. Compliance with interim RAOs is used to assess whether an alternative meets the criterion of overall protection of human health and the environment. The alternatives are described briefly below.

Alternative 1 – No Action. The No Action alternative serves as a baseline against which other options are compared. This action is required for consideration by the NCP. It is evaluated to determine the risks to public health and the environment if no additional actions were taken. This alternative is not acceptable because it does not meet the RAOs for this interim action.

Alternative 2 – Institutional Controls. Institutional controls can be used to help mitigate the impact of TCE in groundwater. For Site 29, these actions could include restricting the installation of new water supply wells, restricting current water use, and providing an alternative water supply to downgradient production wells, thereby limiting exposure of workers to contaminated water.

This alternative would reduce risks associated with the exposure of current and potential future workers to groundwater. However, access restrictions, by themselves, would not address the continued threat from the migration of TCE-contaminated groundwater to downgradient production wells and the persistence of TCE concentrations greater than the MCL. This alternative is not acceptable because it does not satisfy most of the interim RAOs.

Alternative 3 – Monitored Natural Attenuation. Monitored natural attenuation would include ongoing semiannual groundwater monitoring to evaluate the intrinsic attenuation of TCE. This alternative includes those administrative procedures that are currently in place at AFP 42, but does not include any additional administrative procedures such as those described under Alternative 2, Institutional Controls, nor any aspects of active remediation.

TCE concentrations in groundwater would be allowed to naturally decrease over time. The absence of significant detections of TCE degradation products and relatively high dissolved oxygen present in shallow groundwater indicates that naturally occurring biodegradation is a minor factor. Groundwater modeling indicates that the expected time to reach TCE concentrations at or below MCL would be very long, and TCE would reach the production wells at concentrations greater than the MCL in 10 to 15 years. The Monitored Natural Attenuation alternative does not meet the RAOs established for this interim action and, therefore, is not an acceptable alternative.

Alternative 4 – Groundwater Containment and Source Area SVE. Alternative 4 includes containment and treatment of TCE-contaminated groundwater to protect downgradient water supply production wells DW1-1 and DW1-3 (Figure 5). Groundwater containment will be achieved using a groundwater extraction, treatment, and injection system at Site 29. The activities with this alternative will include the installation of three new extraction wells, construction of a groundwater treatment system (GWTS) including liquid-phase granular activated carbon (LGAC) treatment units, and installation of one injection well. Water will be pumped from the three extraction wells and then filtered and treated by the GWTS prior to injection back into the aquifer.

Carbon adsorption is known to be effective for treatment of TCE, and effluent concentrations below the MCL are readily attainable. In addition, injection of the extracted water back into the aquifer would achieve beneficial reuse of the groundwater and help flush the contaminated source zone by increasing the hydraulic gradient. Based on the proposed extraction/injection scenario, groundwater modeling indicates containment of the TCE plume, and the TCE plume would not reach well DW1-1, the closer of the two production wells. Groundwater modeling further suggests that TCE concentrations would decrease to less than the MCL after approximately 20 to 25 years.

This alternative also includes continued operation of the existing SVE system at Site 29 (refer to Section 5.0) to reduce TCE mass in the vadose zone beneath Building 150, the source area. No modifications to the SVE system would be required. This alternative also includes those

administrative procedures that are currently in place at AFP 42 and meets the RAOs established for this interim action.

9.0 Evaluation of Alternatives

The RAP/IA evaluates each alternative against the selection criteria set forth in the NCP. The nine criteria are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria.

The following threshold criteria must be satisfied in order for an alternative to be eligible for selection.

- **Overall protectiveness of human health and the environment** – This criterion considers how the alternative, as a whole, achieves and maintains protection of human health and the environment.
- **Compliance with Applicable or Relevant and Applicable Requirements (ARARs)** – This criterion considers how the alternative complies with ARARs, or if a waiver is required and how it is justified.

The following primary balancing criteria are used to weigh major tradeoffs among the alternatives.

- **Long-term effectiveness and permanence** – This criterion considers the long-term effectiveness of alternatives in maintaining protection of human health and the environment.
- **Reduction of toxicity, mobility, or volume through treatment** – This criterion considers the anticipated effectiveness of the alternative to reduce toxicity, mobility, or volume of the contaminant through treatment.
- **Short-term effectiveness** – This criterion considers the effectiveness of alternatives in protecting human health and the environment during construction and implementation of a remedy.
- **Implementability** – This criterion considers the technical and administrative feasibility of alternatives and the availability of required goods and services.
- **Cost** – This criterion estimates the capital costs and operation and maintenance (O&M) costs of each alternative.

The following modifying criteria will be evaluated following comments on the RAP/IA and this PP and will be addressed once a final decision is being made and the Record of Decision (ROD) is being prepared.

- **State acceptance** – This assessment reflects the state's apparent preference among or concerns about alternatives.
- **Community acceptance** – This assessment reflects the community's apparent preferences or concerns about alternatives.

In the RAP/IA, the alternatives are evaluated individually against the two threshold and five primary balancing criteria, and then the different alternatives are compared to determine specific strengths and weaknesses that must be balanced. Table 1 summarizes and compares the different alternatives on these seven criteria. Table 2 presents a ranking of how well each alternative meets the specific criteria objectives.

10.0 Preferred Alternative

Based on the evaluation of the four interim remedial action alternatives, the preferred alternative for Site 29 is Alternative 4 – Groundwater Containment and Source Area SVE. This alternative includes groundwater containment using a groundwater extraction, treatment, and injection system and continued operation of the existing SVE system to reduce TCE mass in the vadose zone.

This alternative is recommended because it offers the following advantages.

- Mitigates current and potential future exposure to TCE in groundwater
- Will comply with regulatory requirements
- Is the most protective of human health and the environment until a final remedy is implemented
- Unlike the other remedial action alternatives, Alternative 4 would be more acceptable to the Air Force and regulatory agencies

11.0 Uncertainties

Numerical transport and groundwater flow models were used to assist in the development of various scenarios evaluated, including the recommended Alternative 4. These models were used to estimate extraction and injection well locations, pumping and injection rates, and TCE migration travel times. All modeling is subject to uncertainties, limitations, and assumptions. The RAP/IA describes in detail the models used and their uncertainties, limitations, and key assumptions.

12.0 References

CH2M HILL. 2003. *Final Remedial Investigation for Operable Units 1, 2, 3, 4, and 5, Air Force Plant 42, Palmdale, California.* (Amended 2004).

CH2M HILL. 2006. *Final Remedial Investigation Report Addendum, Results of Additional Remedial Investigation at IRP Site 29, Air Force Plant 42, Palmdale, California.* June.

CH2M HILL. 2008a. *Final Results of the 2007 Semiannual Groundwater Monitoring Events at IRP Site 29, Air Force Plant 42, Palmdale, California.* January.

CH2M HILL. 2008b. *Final Soil Vapor Extraction System Installation and Startup Report for IRP Site 29, Air Force Plant 42, Palmdale, California.* May.

CH2M HILL 2008d. *Final Semiannual Treatability Study Report Soil Vapor Extraction System at IRP Site 29, Palmdale, California.* May.

CH2M HILL. 2008c. *Public Draft Remedial Action Plan/Interim Action for the Interim Remedial Action at IRP Site 29 Air Force Plant 42, Palmdale, California.* October.

Appendix A - Glossary

Applicable or Relevant and Appropriate Requirements (ARARs)	State or federal laws, regulations, or standards from programs other than Superfund that pertain to protection of human life and the environment in addressing specific conditions or use of a particular treatment technology.
Aquifer	A water-bearing reservoir capable of yielding enough water to satisfy a particular demand.
Biodegradation	To breakdown or decompose under natural conditions, especially by bacteria, and become absorbed by the environment.
Cancer Risk	The estimated risk of chemical(s) that cause cancerous health effects for a given concentration. The cancer risk is generally expressed in exponential form (i.e., 1×10^{6}, which means one-in-one-million), which describes the increased possibility of an individual developing cancer from exposure to the chemical(s) under assumed exposure conditions.
Capillary Forces	The forces that hold water in small spaces between soil particles.
Capital Costs	Expenditures required to construct a remedial action. They are exclusive of costs required to operate or maintain the action.
Capture Zone (for SVE systems)	The zone above the water table where unsaturated soil allows air flow when a vacuum is applied.
Chemical of Concern (COC)	Site-specific chemicals that are identified by investigations and risk assessments as presenting a threat to human health or the environment.
Ecological Risk Assessment	A methodology used to determine if a particular chemical poses a significant risk to the environment and, if so, under what circumstances.
Human Health Risk Assessment	A methodology used to determine if a particular chemical poses a significant risk to human health and, if so, under what circumstances.
Liquid-phase Granular Activated Carbon (LGAC)	A treatment technology that removes organic compounds from water by using granular-sized activated carbon. Activated carbon is a black, solid porous substance with a very large surface area. Certain contaminants accumulate on and bind strongly to the surface of the activated carbon.
Maximum Contaminant Level (MCL)	The legal threshold limit on the amount of a hazardous substance that is allowed in drinking water established by the Environmental Protection Agency (EPA). The limit is usually expressed as a concentration in milligrams or micrograms per liter of water.

Metals Mobilization	The release of metals bound to soil particles in the aquifer, allowing them to dissolve into the groundwater.
National Contingency Plan (NCP)	The federal government's regulations for implementing the natural superfund program. These regulations provide the framework for the Remedial Investigation/Feasibility Study (RI/FS) process and cleanup requirements.
Noncancer Risk	The estimated risk of chemical(s) that are not known to cause cancerous health effects for a given concentration. Noncancer risk is expressed in terms of a hazard index (HI), which is the ratio of the estimated concentration to which an individual is being exposed to a threshold level concentration that would likely result in adverse health effects. If the HI is above 1.0, then there is a possibility that there might be adverse health concerns caused by the chemical(s) under assumed exposure conditions.
Operation and Maintenance (O&M)	The actions taken after remedy construction to ensure that the constructed system will be properly operated and monitored to maintain cleanup efficiency.
Pilot Testing	The testing of a treatment system under the operating conditions and in the environment for which the system was designed. The test is used to gather data necessary for the final selection of the cleanup method.
Proposed Plan (PP)	A document that summarizes the proposed method(s) of cleanup for a site or group of sites, the rationale for their selection including a summary of the Remedial Investigation and Feasibility Study results, and a summary of the alternatives considered for each site.
Radius of Influence (ROI)	In soil vapor extraction systems, the radius of influence is defined as the greatest distance from an extraction well at which a sufficient vacuum and vapor flow can be induced.
Record of Decision (ROD)	A public decision document that explains which cleanup alternative(s) will be used based on the analysis of the Feasibility Study.
Remedial Action Plan/Interim Action (RAP/IA)	A public document that provides the work plan for performing interim remedial action at an environmental site. The interim action is necessary to address promptly any threat to public health and the environment and is intended to be compatible with the final remedy for the site.
Remedial Investigation (RI)	An in-depth study designed to gather data needed to determine the nature and extent of contamination and risks to human health and the environment at a site.

Residual Saturation	The saturation level in the vadose zone (or capillary zone) below which fluid drainage by gravity will not occur.
Saturated Zone	The area below the water table where all open spaces are filled with water under pressure equal to or greater than that of the atmosphere.
Soil Vapor Extraction (SVE)	An in-place process for soil remediation where contamination is removed from soil under a vacuum using a medium such as air or steam. SVE is suitable for removing a variety of volatile organic compounds that have a high vapor pressure or a low boiling point compared to water, such as chlorinated solvents.
Trichloroethylene (TCE)	A stable, low boiling-point, colorless liquid that is toxic if inhaled. TCE is a chlorinated solvent formerly used as an industrial degreasing compound.
Vadose Zone	The unsaturated zone which occurs above the water table where the soil pores are only partially filled with water (the moisture content is less than the porosity). This zone is limited above by the land surface and below by the surface of the saturated zone.
Vapor Phase	A gas at a temperature below its critical temperature.
Vapor-phased Granular Activated Carbon (VGAC)	A treatment technology that removes organic compounds from air (i.e., vapor) by using granular-sized activated carbon. Activated carbon is a black, solid, porous substance with a very large surface area. Certain contaminants accumulate on and bind strongly to the surface of the activated carbon.

Tables

Table 1
Summary and Comparison of Alternatives
Air Force Plant 42

Alternative	Description	Threshold Criteria		Balancing Criteria				Net Present Value (NPV) Cost	Non-Discounted Cost
		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction in Toxicity, Mobility, or Volume Through Treatment	Short-term Effectiveness	Implementability		
Alternative 1	No Action	Poor. RAOs would not be achieved. Risk to human receptors would not be diminished.	Poor. Alternative would not comply with ARARs.	Poor. Any identified risk would not be diminished.	Poor. No treatment or reduction in toxicity, mobility, or volume.	Not applicable. Alternative has no remedial action; therefore, no additional impacts would result from implementation of technologies.	Not applicable.	$0	$0
Alternative 2	Institutional Controls	Poor. Although risks associated with groundwater contact and installation of drinking water wells would be reduced, most of the RAOs would not be achieved.	Poor. Alternative would not comply with ARARs.	Poor. Any identified risk would not be diminished.	Poor. No treatment or reduction in toxicity, mobility, or volume.	Not applicable. Alternative has no remedial action; therefore, no additional impacts would result from implementation of technologies.	Very good. Would have additional administrative requirements and therefore need for coordination among the Air Force, state agencies and Plant Site 1 tenant.	$363,800	$543,000
Alternative 3	Monitored Natural Attenuation	Poor. RAOs would not be achieved. Risk to human receptors would not be diminished.	Poor. Alternative would not comply with ARARs.	Poor. Groundwater TCE concentrations would decrease naturally but over a very long time.	Poor. No reduction in toxicity, mobility, or volume of TCE through treatment.	Not applicable. Alternative has no active remediation component; therefore, no additional impacts would result from continued long-term monitoring of groundwater.	Very good. Groundwater monitoring technology well-established, reliable, and readily available. Alternative requires coordination with state agencies.	$1,555,700	$2,322,000
Alternative 4	Groundwater Containment and Source Area SVE	Very good. Groundwater containment (extraction, treatment, and reinjection) would reduce the risk to human health and the environment while protecting downgradient water supply wells. Further impacts to groundwater from residual TCE in the vadose zone would be mitigated by the continued operation of the SVE system.	Very good. Alternative would comply with ARARs, with hydraulic control of the TCE plume achieved and maintained.	Very good. LGAC treatment of TCE in groundwater is effective and permanent. VGAC treatment of soil gas is an effective and permanent treatment of TCE in the source area vadose zone.	Very good. Groundwater extraction would reduce TCE mobility through hydraulic control, and reduce toxicity through extraction and treatment (LGAC). SVE removal intrinsically decreases the mobility and mass or volume of TCE in the vadose zone, and treats TCE using VGAC.	Very good. The time to install the groundwater containment system is typically 3 to 6 months. Risks to workers and community during installation of the groundwater containment system can be readily minimized or eliminated with appropriate standard safety practices. The source area SVE component is already installed.	Very good. Groundwater containment (extraction, treatment, and reinjection) and SVE technologies are well-established and reliable. Materials and services required are readily available. Injection requires coordination with the state agencies.	$12,253,400	$13,251,200

Notes:
The "modifying criteria" of state acceptance and community acceptance are generally evaluated after public comment on the Remedial Action Plan/Interim Action and Proposed Plan.
ARARs - applicable and relevant or appropriate requirements
LGAC - liquid-phase granular activated carbon
NPV - net present value
RAOs - remedial action objectives
SVE - soil vapor extraction
SWRCB - State Water Resources Control Board
TCE - trichloroethylene
VGAC - vapor-phase granular activated carbon

Table 2
Relative Ranking and Comparison of Remedial Alternatives
Air Force Plant 42

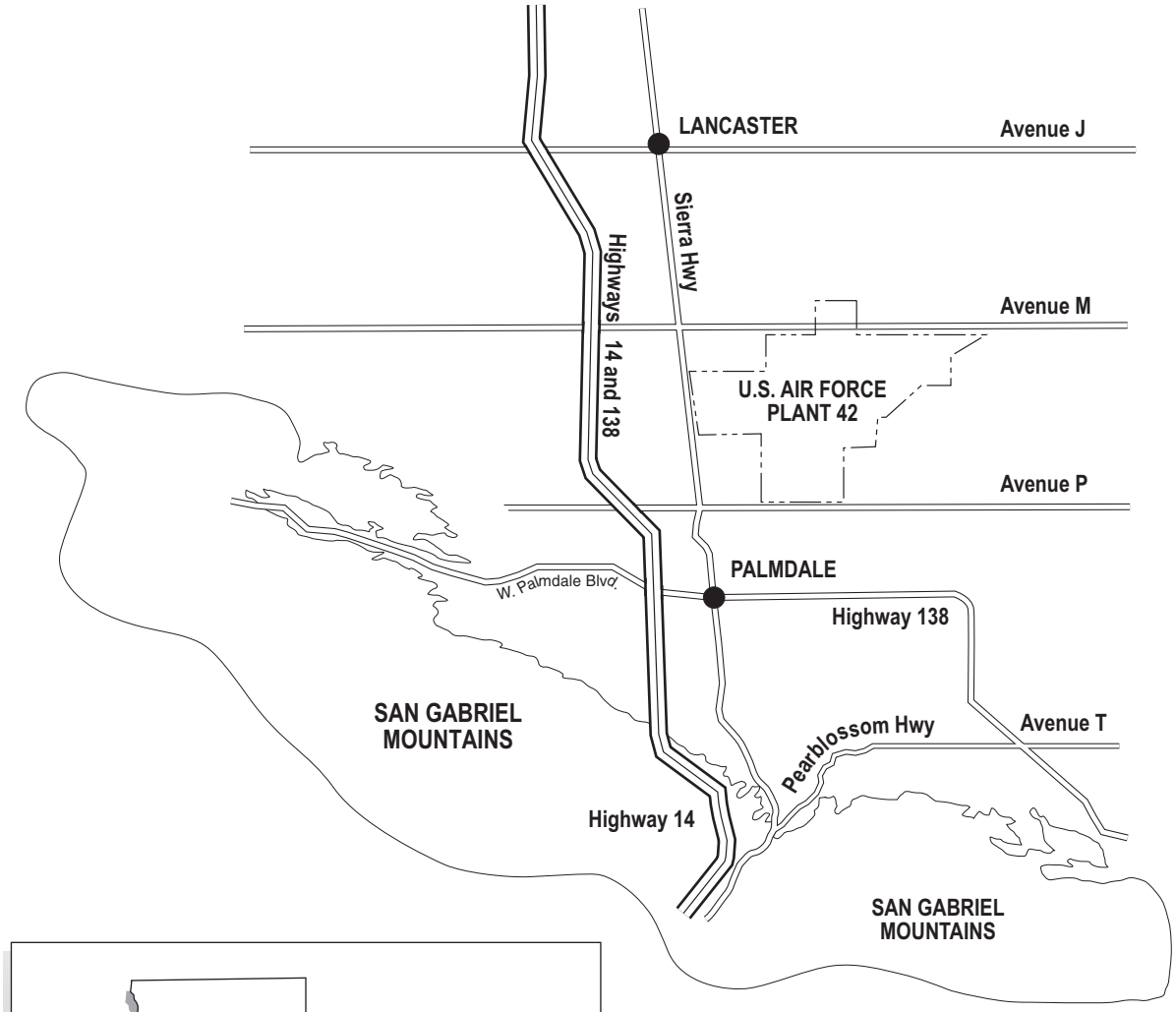
Remedial Alternative	Remedial Alternative Description	Threshold Criteria		Balancing Criteria					
		Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction in Toxicity, Mobility, or Volume Through Treatment	Short-term Effectiveness	Implementability	Cost	Overall Grade
Alternative 1	No Action	C	C	C	C	NA	NA	NA	C
Alternative 2	Institutional Controls	C+	C	C	C	NA	A	A	C+
Alternative 3	Monitored Natural Attenuation	C	C	C+	C	NA	A	B +	C+
Alternative 4	Groundwater Containment and Source Area SVE	A	A	A	A	A	B	C	A-

Notes:
Letter symbols appearing before criteria explanations are a relative ranking of how well the alternative meets the specific criteria objectives. "A" is the highest rank, "C" is the lowest rank, and "B" is a medium rank.

The "modifying criteria" of state and community acceptance are generally evaluated after public comment on the Feasibility Study and Proposed Plan.

SVE - soil vapor extraction
RAOs - remedial action objectives
TCE - trichloroethylene
ARARs - applicable and relevant or appropriate requirements
LGAC - liquid-phase granular activated carbon
NA - not applicable

Figures



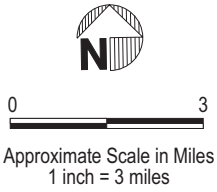


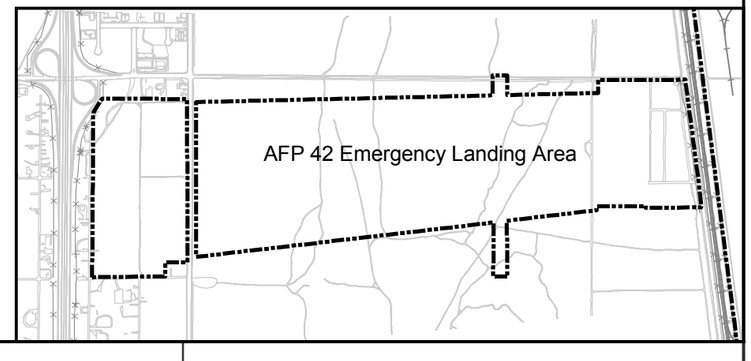
Figure 1
Location Map
AFP 42

CH2MHILL

IRP Site 29 (Groundwater at Plant Site 1)

MW-W2
MW-W1
20th Street East
Avenue M
Plant Site 1
Plant Site 2
Plant Site 3
Plant Site 4
MW1-1
MW1-2
MW1-9
MW1-10
MW1-12
MW1-13
MW1-4
MW1-5
MW1-11
MW1-3
MW1-8
DW1-1
DW1-3
MW1-6
MW1-7
MW2-1
DW2-2
MW2-2
DW2-1
MW3-2
FW-2C
DW3-3
DW3-2
FW-2B
DW3-1
MW3-1
DW4-2
DW4-1
MW4-1
AFP 42 Emergency Landing Area (See Inset A)
Common Areas (Plant Site 5)
MW5-1
MW-3
MW-2
MW-1
Common Areas (Plant Site 5)
Sierra Highway
Plant Site 8
DW8-1
MW8-1
Plant Site 7
DW7-1
Plant Site 6
FW1
DW10-1
15th Street East
20th Street East
25th Street East
DWX-2
DWX-1
PWD 15
Avenue P (Rancho Vista)

Inset A



Monitoring Well
Production Well (Public Water Supply)
Air Force Plant 42 Boundary
Industrial Plant Site Boundary
Security Fence
Railroad
Road
Installation Restoration Program (IRP) Site 29 (Plant Site 1) Boundary

N
0 2,000 4,000 Feet
Source: Aeronautical Systems Center (ASC), 2004

Figure 2
Air Force Plant 42 Layout
Air Force Plant 42

CH2MHILL
Date: 09/04/2008

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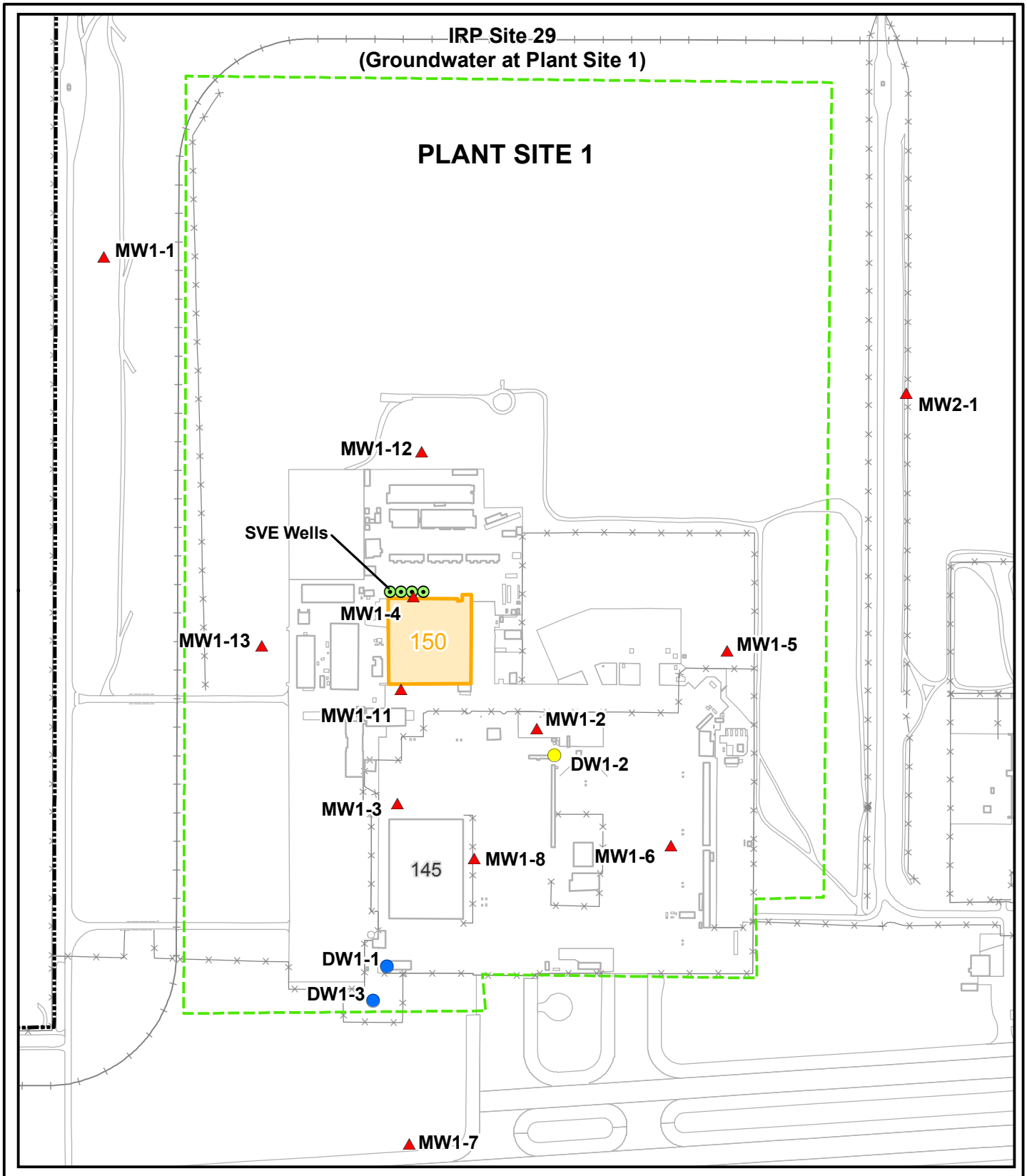

Legend:

- Monitoring Well
- Production Well
- Abandoned Production Well
- SVE Well
- AFP 42 Boundary
- Fences
- Roads
- Railroad
- IRP Site

N

0 500 Feet

Note:
- IRP Site boundaries and sizes are approximate.

Figure 3
Plant Site 1 Wells and Building 150
Air Force Plant 42 Palmdale, California

CH2MHILL

Date:09/22/2008

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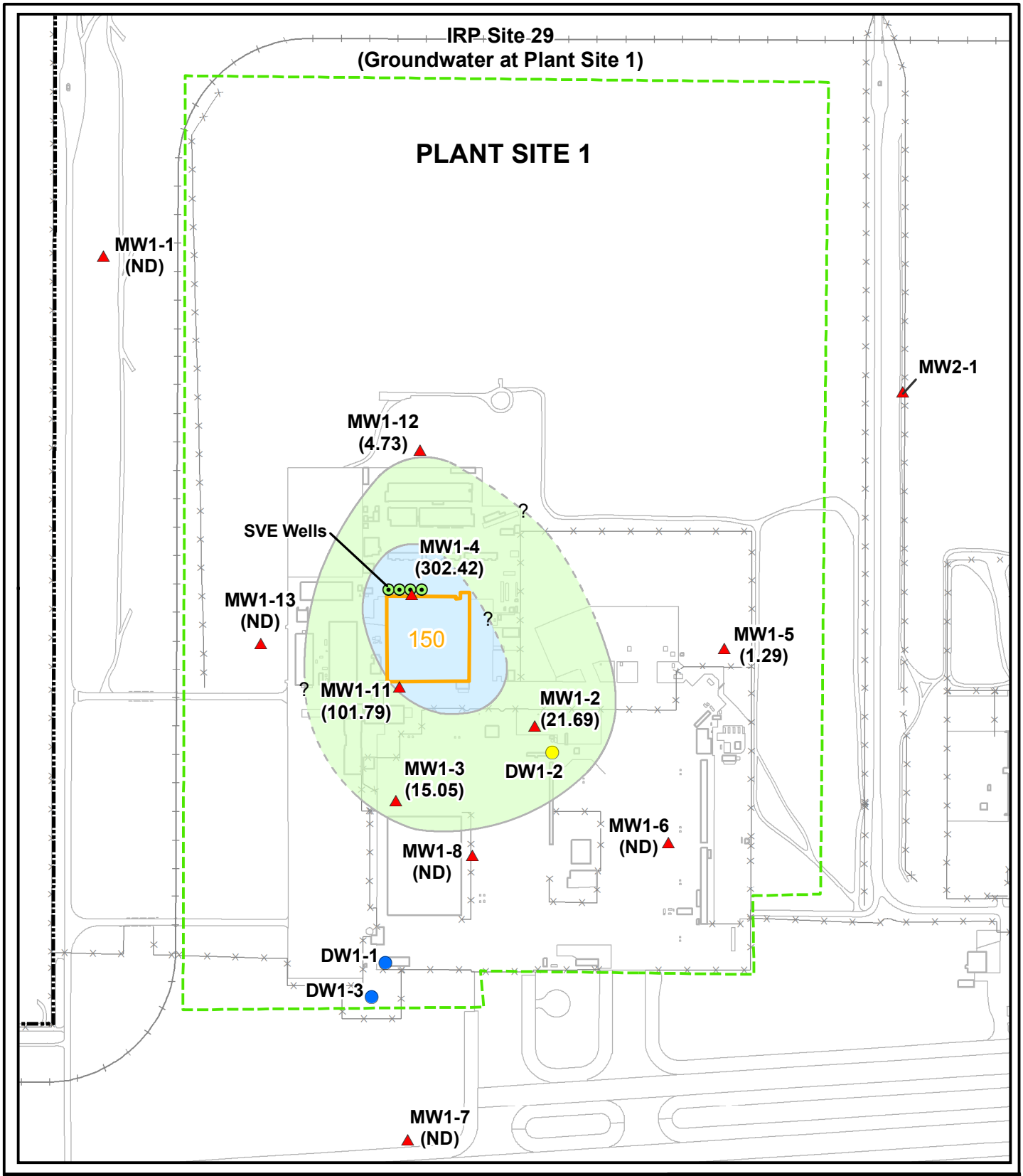

Legend:

- Monitoring Well
- Production Well
- Abandoned Production Well
- SVE Well
- AFP 42 Boundary
- Fences
- Roads
- Railroad
- IRP Site

TCE Concentration

- Greater than 100 ppb
- Between 5 and 100 ppb

N

0 500 Feet

Note:
- IRP Site boundaries and sizes are approximate.

Figure 4
TCE Concentration in Shallow Groundwater IRP Site 29 March 2008 Sample Event

Air Force Plant 42 Palmdale, California

CH2MHILL

Date: 09/04/2008

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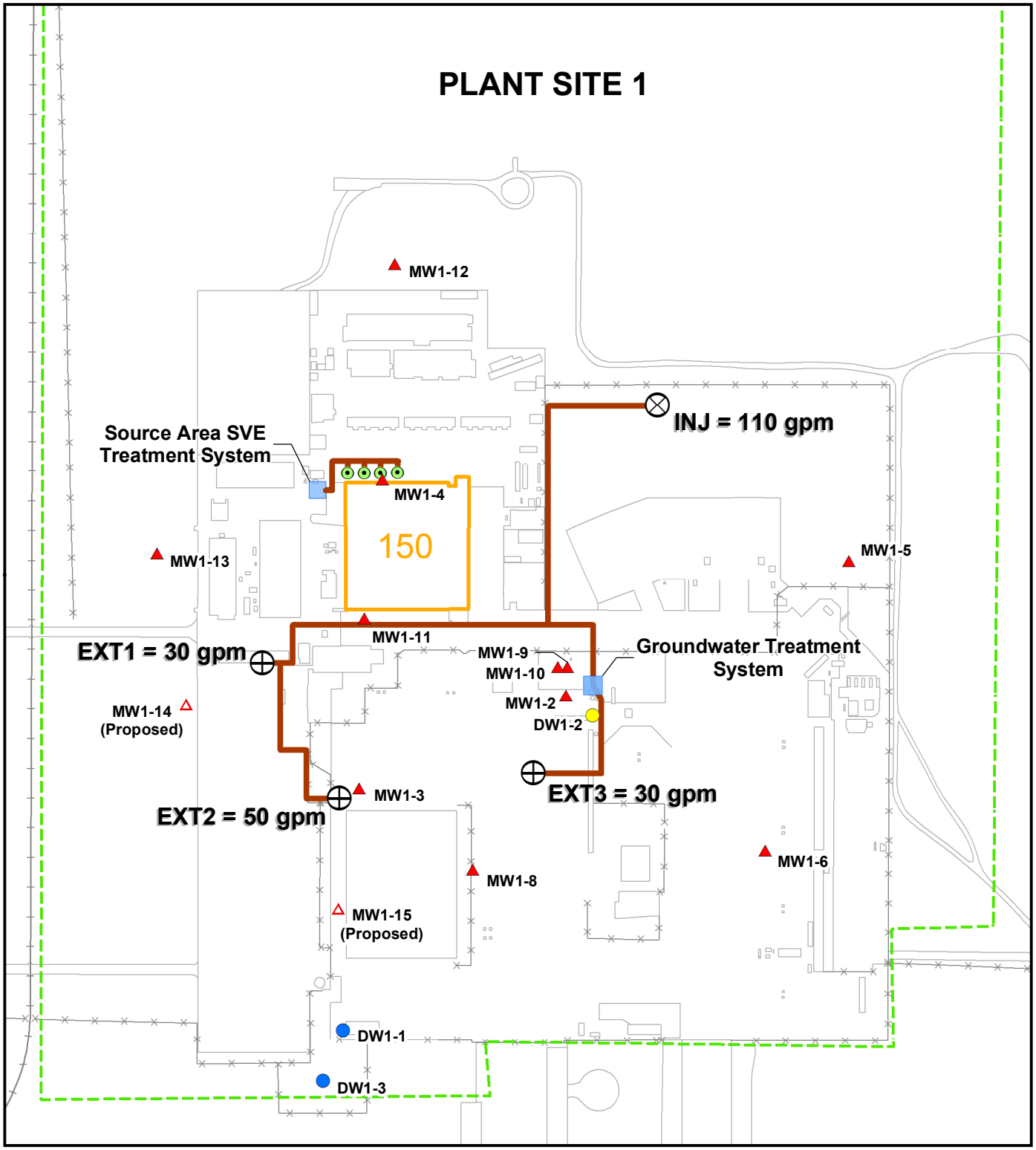

Legend:

- Monitoring Well
- Proposed Monitoring Well
- Production Well
- Abandoned Production Well
- Proposed Injection Well
- Proposed Extraction Well
- SVE Extraction Well
- Proposed Pipeline
- AFP 42 Boundary
- Fences
- Roads
- IRP Site
- Proposed Treatment Facility

N

0 350 Feet

Note:
- IRP Site boundaries and sizes are approximate.

Figure 5
Assumed Layout
Alternative 4
Groundwater Containment and Source Area SVE
Air Force Plant 42
Palmdale, California

CH2MHILL

Date: 09/04/2008

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